PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H05K 3/34, B23K 1/005

A1

(11) International Publication Number: WO 99/18762

(43) International Publication Date: 15 April 1999 (15.04.99)

(21) International Application Number: PCT/GB98/02981

(22) International Filing Date: 5 October 1998 (05.10.98)

(30) Priority Data:
08/944,428 6 October 1997 (06.10.97) US

(71) Applicant (*for all designated States except GB*): FORD MOTOR COMPANY [US/US]; The American Road, Dearborn, MI 48124 (US).

(71) Applicant (*for GB only*): FORD MOTOR COMPANY LIMITED [GB/GB]; Eagle Way, Brentwood, Essex CM13 3BW (GB).

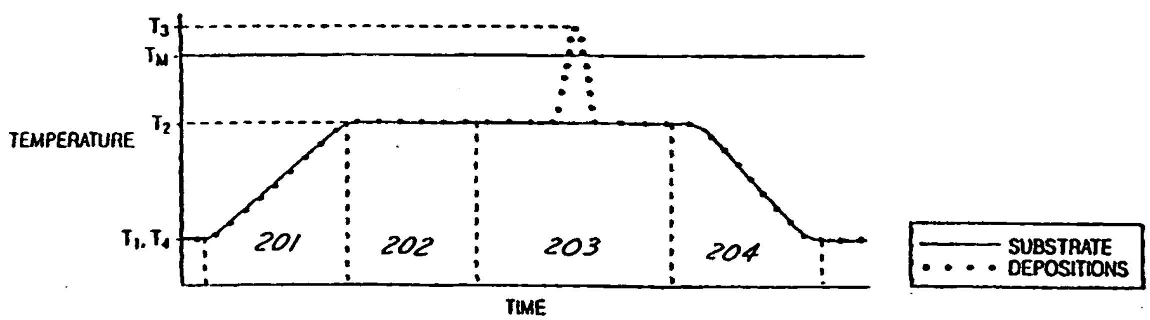
(72) Inventors: QUILTY, William, F., Jr.; 11 Cobalt Cross Road, Levittown, PA 19057 (US). SINKUNAS, Peter, Joseph; 7111 Foxcreek Drive, Canton, MI 48187 (US). PARIKH, Mayank; 42312 Metaline Drive, Canton, MI 48187 (US). McLESKEY, Edward, P.; 2115 Watkins Lake Road, Waterford, MI 48328 (US). LEMECHA, Myron; 620 S. Silvery Lane, Dearborn, MI 48124 (US). GLOVATSKY, Andrew, Z.; 37803 Arbor Woods Drive, Livonia, MI 48150 (US). BAKER, Jay, DeAvis; 4210 Hardwoods Drive, P.O. Box 1678, Dearborn, MI 48121 (US).

(74) Agent: MESSULAM, Alec, Moses; A. Messulam & Co., 24 Broadway, Leigh on Sea, Essex SS9 1BN (GB).

(81) Designated States: CA, CN, JP, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: METHOD FOR CONNECTING SURFACE MOUNT COMPONENTS TO A SUBSTRATE



(57) Abstract

There is disclosed herein a method and apparatus for connecting surface mount components to a substrate, comprising the steps of: (1) providing an electronic assembly which includes solder paste depositions atop mounting pads on a substrate and at least one electronic component having terminations arranged such that each termination rests atop a respective mounting pad; (2) preheating the assembly from a first temperature T_1 to a second temperature T_2 below the melting point T_M of the solder paste; (3) soaking the assembly at substantially the second temperature T_2; (4) selectively heating each solder paste deposition to a third temperature T_3 above the melting point of the solder paste depositions while maintaining the substrate at substantially the second temperature T_2; and (5) cooling the assembly to a fourth temperature T_4 below the second temperature T_2.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

METHOD FOR CONNECTING SURFACE MOUNT COMPONENTS TO A SUBSTRATE

The present invention relates generally to surface mount components. More particularly, the present invention relates to a method for connecting surface mount components to a substrate.

Surface mount electronic components are typically attached to a printed circuit board (PCB) by a process of (1) applying solder paste to mounting pads on the PCB, (2) placing the components on the PCB such that the component terminations rest on their respective solder-pasted mounting pads, thereby forming a PCB assembly, and (3) sending the PCB assembly through a solder reflow oven. As a PCB assembly passes through the reflow oven, the solder paste depositions on the PCB are melted and allowed to reflow so that a molten solder joint is formed between each component termination and its associated mounting pad. Then, the reflow oven allows the molten joints to cool so that a solid solder joint is formed between each component termination and its respective mounting pad.

Conventional reflow ovens accomplish this process of melting, reflowing, and cooling by providing various temperature zones within the oven, each of which the PCB assembly is exposed to for a specified length of time. This sequence of temperature zones and exposure times is referred to as a temperature-versus-time profile, or simply a temperature profile for short. Most reflow ovens can be programmed to provide a variety of temperature profiles in order to accommodate various combinations of substrate materials, solder paste formulations, component types and densities, etc. However, all conventional reflow ovens follow a basic temperature profile, as illustrated in FIG. 1.

This profile consists of four sequential temperature zones. The first is a "preheat" zone 101, which brings the entire PCB assembly from some initial, lower temperature T_1

(usually ambient) to a second, elevated temperature T_2 lower than the melting point T_M of the solder paste. The second zone is an "equilibrium" or "soak" zone 102, in which the PCB assembly is held at essentially T_2 to assure that the entire assembly–i.e., substrate, components, and solder paste–is brought up to this temperature T_2. Next is the "reflow" zone 103, in which the assembly is elevated to a temperature T_3 above the melting point T_M of the solder paste in order to melt and reflow the paste. Finally, the assembly is then sent through a "cool-down" zone 104 which gradually brings the assembly temperature down from T_3 to a fourth temperature T_4. This fourth temperature T_4 is below that of the second temperature T_2, and is usually about the same as the first temperature T_1 (i.e., typically ambient). Note in FIG. 1 that the overall temperatures of the substrate and the solder depositions–represented by solid and dotted lines, respectively–are essentially the same at all points along the temperature profile.

This process of melting, reflowing, and cooling is acceptable when processing PCBs made of conventional substrate materials, such as FR-4 (glass-filled epoxy laminates), glass-filled PET (polyethylene terepthalate), glass-filled polyamide (e.g., Nylon-6), glass-filled polyetherimide, and flex circuit substrates made from high temperature materials such as polyimide. However, when a lower melting point substrate material is used (e.g., polypropylene, or non-glass-filled polyamide or PET), the reflow temperature T_3 to which the assembly would be subjected in a conventional reflow oven may be too high, causing unacceptable softening, melting, and/or thermal degradation of the substrate material.

It would be desirable, therefore, to provide a method for melting, reflowing, and cooling solder paste depositions on a PCB assembly so as to form a solid solder joint between each component termination and its associated mounting pad without having to subject the entire substrate to the high reflow zone temperatures of conventional reflow ovens.

The present invention overcomes the disadvantages of the prior art by providing a method for connecting surface mount components to a substrate without subjecting the overall substrate to unacceptably high reflow zone temperatures. The method comprises the steps of: (1) providing an electronic assembly which includes solder paste depositions atop mounting pads on a substrate and at least one electronic component having terminations arranged such that each termination rests atop a respective mounting pad; (2) preheating the assembly from a first temperature to a second temperature below the melting point of the solder paste; (3) soaking the assembly at substantially the second temperature; (4) selectively heating each solder paste deposition to a third temperature above the melting point of the solder paste depositions while maintaining the substrate at substantially the second temperature; and (5) cooling the assembly to a fourth temperature below the second temperature. The method may also be practised using bonding compounds other than solder paste, such as thermal-curing, electrically conductive adhesive. An apparatus for carrying out this method is also provided.

It is an advantage that the present invention provides a process and apparatus for forming electrically conductive bonding compound joints between component terminations and their respective substrate mounting pads without subjecting the whole PCB substrate to high reflow zone temperatures. This permits the use of low melting point substrate materials in the PCB assembly.

It is another advantage that the present invention may be used with both conventional and low melting point substrate materials.

It is a further advantage that a surface mount component may be connected to its associated substrate much quicker according to the present invention than according to conventional reflow oven processing.

These and other advantages, features and objects of the invention will become apparent from the drawings, detailed description and claims which follow.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a schematic diagram of a typical temperature profile within a conventional solder reflow oven;

FIG. 2 is a schematic diagram of a temperature profile for selectively reflowing bonding compound depositions according to the present invention;

FIGS. 3-4 are perspective views of heating energy being selectively applied to single and multiple bonding compound depositions, respectively, according to the present invention;

FIG. 5 is a schematic diagram of a typical temperature profile for conventional laser soldering; and

FIG. 6 is a schematic diagram of an apparatus for selectively reflowing bonding compound depositions according to the present invention.

Referring now to the drawings, FIG. 2 shows a schematic representation of a specialised temperature profile for reflowing bonding compound depositions according to the present invention. The bonding compound used may be a solder having a melting point T_M, a thermal-cure electrically conductive adhesive having an activation point T_M, or the like. As in the prior art reflow process described above, the temperature profile of the present invention includes a pre-heat zone 201, an equilibrium zone 202, a reflow zone 203, and a cool-down zone 204. As in FIG. 1, the overall temperature of the substrate is denoted in FIG. 2 by a solid line, while that of the bonding compound depositions is denoted by a dotted line.

Note that the preheat, equilibrium, and cool-down zones of the present invention 201/202/204 are similar to those of the prior art 101/102/104. That is, both the conventional

process and a process according to the present invention have: (1) a preheat zone 101/201 which elevates the temperature of the overall assembly from a first predetermined temperature T_1 (usually ambient, or about 25°C) to a second predetermined temperature T_2 below the melting/activation point T_M of the bonding compound; (2) a soak zone 102/202 wherein the temperature of the overall assembly is maintained at substantially the second temperature T_2; and, following the reflow zone 103/203, (3) a cool-down zone 104/204 wherein the temperature of the overall assembly is gradually reduced from the ending temperature of the reflow zone (typically T_2) down to a fourth predetermined temperature T_4 (usually the same as T_1 or ambient).

The conventional reflow process and that of the present invention also include a reflow zone 103/203 following the preheat and soak zones. However, the temperature profile of the present invention's reflow zone 203 differs markedly from that of the conventional reflow process 103. Note that whereas both the substrate and bonding compound depositions undergo a temperature increase from the second temperature T_2 to a third predetermined temperature T_3 above the melting/activation point T_M of the deposition material in the conventional process shown in FIG. 1, in the present invention only the depositions undergo a temperature increase from T_2 to T_3, while the overall substrate temperature remains at essentially its previous temperature T_2. This divergence between the substrate and deposition temperatures is caused by selective further heating of only the depositions.

As illustrated by FIG. 2, the overall PCB assembly is maintained at essentially T_2 throughout the entire reflow process 203. This essentially constant heating may be provided, for example, by a modified conventional reflow oven, while the aforementioned selective heating of the bonding compound depositions (represented by the spiked, dotted line in zone 203) may be accomplished by such means

as focusing a laser, xenon light, or other heating energy source 10 at one or more bonding compound depositions 20. (These depositions 20 may be heated directly, or indirectly by focusing the energy source 10 at the component terminations resting atop each deposition as shown in FIGS. 3-4.) Each beam of heating energy can be selectively directed at only one deposition, as shown in FIG. 3, or at several depositions at once, as shown in FIG. 4. In this way, essentially only the depositions are heated to T_3, causing the bonding compound to melt (if a solder) or activate (if a thermal-cure adhesive) without subjecting the entire substrate to the elevated reflow temperature T_3. This avoids raising the overall substrate temperature dangerously close to a critical temperature of the substrate material, thus allowing the use of low melting point substrate materials. Any peripheral areas 30 of the substrate immediately around or between the depositions 20 might also be incidentally or indirectly heated by the heating energy source 10, but even these small areas 30 are unlikely to be heated to T_3 or even to a critical temperature of the substrate. (As used here, "critical temperature" refers to a melting point, structural deformation point, or thermal degradation point of the substrate material.)

It should be noted that for the sake of simplicity, FIG. 2 shows only a single temperature burst in the reflow zone 203. This would be the profile if only one deposition were being reflowed using a single burst from the heating source 10, or if more than one deposition were being simultaneously reflowed using a single burst. In practice, however, a sequence of bursts would most likely be used during the reflow process 203 (i.e., one or more bursts for each single deposition or set of depositions).

An apparatus 400 for providing the specialised temperature profile of the present invention is illustrated in FIG. 6, and includes: means 401 for preheating a PCB assembly from T_1 to T_2; means 402 for soaking the assembly at substantially T_2; means 403 for selectively heating each

bonding compound deposition to T_3; and means 404 for cooling the assembly to T_4. (T_1 through T_4 have the same meaning here as above.) The preferred embodiment of such an apparatus 400 is a modified reflow oven wherein the means 401/402/404 for preheating, soaking, and cooling comprise the respective preheating, soaking, and cool-down portions of a conventional reflow oven. These portions are well known to those skilled in the art to which the present invention pertains.

The means 403 for selectively heating each deposition to T_3 comprises one or more non-contact thermal energy sources 405 arranged within a reflow zone section of the oven for providing the burst(s) of heating energy to each deposition. Means 403 may further include means 406 for selectively focusing and/or directing the heating energy from the heating source onto each deposition (such as mirrors, lenses, fibre optics, and/or other optical elements), means 407 for delivering the heating energy to each deposition in intermittent bursts (such as pulse/discharge control units), as well as means 408 for masking the PCB assembly (such as stencils or masks with apertures therein) so that substantially only one or more depositions at a time is/are exposed to the heating energy when the means for selective heating 403 is activated. Although various heating energy sources may be utilised, the preferred type of source is a laser, with a diode laser operating in the frequency range of 900 to 950 nm being the most preferred approach. This frequency range—which can typically be produced only by diode lasers—is preferred because within this range plastic substrates tend to absorb less laser energy than at other frequencies, while absorption by metals (e.g., solder) remains relatively high.

This use of lasers to reflow bonding compound depositions may appear similar to conventional laser soldering, but is actually quite different. In conventional laser soldering, the entire PCB assembly (including its solder paste depositions) is typically provided at ambient

temperature T_1; then, the laser energy directed at the solder paste depositions subjects the depositions to a sudden and steep temperature gradient from around ambient T_1 to a point T_3 above the melting point T_M of the solder paste—e.g., from about 25°C to about 220-280°C. Thus, as illustrated by region 300 in FIG. 5, a sudden reflow is performed, followed by an equally sudden, uncontrolled cool-down—no preheat, soak, or controlled cool-down are involved. In contrast, the present invention involves well-defined preheating, soaking, and controlled cool-down steps. Consequently, the reflow involved in the present invention causes the depositions to traverse a much less drastic thermal gradient to effect reflow—i.e., from T_2 to T_3 to T_2, rather than from T_1 to T_3 to T_1.

The approach of the present invention thus provides several advantages not present in conventional laser soldering. First, the less drastic thermal gradient mentioned above lends itself to the use of lower melting point substrate materials than could be used in conventional laser soldering. Second, this less severe thermal gradient helps form bonding compound joints that are more robust and more consistent. Third, the use of the preheat and soak zones of the present invention allows flux (which may be part of the solder paste, or may be separately applied to the mounting pads) to have more time to do its job of cleaning the metal surfaces of the mounting pads and terminations, removing and preventing oxide formations, and assisting in thermal transfer. And fourth, the smaller thermal gradient allows the use of a lower wattage laser as compared with conventional laser soldering.

The present invention also offers advantages over conventional reflow ovens. One such advantage is that lower melting point substrate materials may be used. This offers increased design flexibility and reduced material costs. Another advantage is that the present invention can be used with both conventional (e.g., FR-4) and lower melting point substrate materials. A further advantage is that the reflow

of solder (or activation of thermal-cure adhesive) in the reflow process 203 of the present invention may be performed much quicker than can typically be done using the conventional reflow process. This is because the selective heating and resultant joint formation may be accomplished much faster than passing the entire PCB assembly through the reflow region 103 of a conventional reflow oven.

One having skill in the art to which the present invention pertains will recognise that the word "reflow", as used herein, may mean (1) simply melting/activating a deposition, or (2) the entire process of melting/activating a deposition, causing/allowing the deposition to flow across the mounting pad on which it sits, and solidifying/curing the deposition into a solid joint connecting a component termination and its respective solder pad. Moreover, those skilled in the art will appreciate that the time scale and specific temperatures T_1 through T_4 that characterise the time-temperature profile disclosed herein will vary from case to case, depending on the substrate materials, bonding compound characteristics (e.g., T_M), component layout densities, and other factors. These factors may be used to determine T_1 through T_4 for each specific case, as well as for determining the rates at which to pre-heat and cool down the assembly, the length of time to soak the assembly, the amounts and rates of thermal energy needed to heat the depositions from T_2 to T_3, etc. (Methods for determining these characteristics are well known in the art.)

Various other modifications to the present invention will, no doubt, occur to those skilled in the art to which the present invention pertains. For example, note that although FIGS. 1 and 2 show their respective temperature profiles as being distinct lines, those skilled in the art will appreciate that not all locations on the PCB will follow this precise curve, but may be slightly higher or lower in temperature at any given point in time. Thus, FIGS. 1 and 2 represent "average" temperatures for a typical

PCB. It is the following claims, including all equivalents, which define the scope of the invention.

CLAIMS

1. A method for reflowing bonding compound on an electronic assembly, in which the assembly includes bonding compound depositions atop mounting pads on a substrate and at least one electronic component having terminations arranged such that each termination rests atop a respective mounting pad, comprising the steps of:

providing said assembly;

preheating said assembly from a first predetermined temperature to a second predetermined temperature;

soaking said assembly at substantially said second predetermined temperature;

selectively heating each bonding compound deposition to a third predetermined temperature above one of a melting point and an activation point of said depositions while maintaining said substrate at substantially said second temperature; and

cooling said assembly to a fourth predetermined temperature below said second temperature.

2. A method according to claim 1, wherein said substrate is constructed of a material having a critical temperature lower than said third predetermined temperature.

3. A method according to claim 2, wherein said critical temperature is one of a melting point, a structural deformation point, and a thermal degradation point of said substrate material.

4. A method according to any one of the preceding claims, wherein at least one of said first and fourth predetermined temperatures is ambient.

5. A method according to any one of the preceding claims, wherein said fourth predetermined temperature is approximately equal to said first predetermined temperature.

6. A method according to any one of the preceding claims, wherein during said selectively heating step said substrate is maintained at a temperature below said third temperature.

7. A method according to any one of the preceding claims, wherein said bonding compound is a solder having a melting point lower than the third predetermined temperature.

8. A method according to claim 7, wherein said selective heating step melts and reflows each deposition so as to form a solder joint connecting each termination with its respective mounting pad.

9. A method according to any one of claims 1 to 6, wherein said bonding compound is a thermal-cure electrically conductive adhesive having an activation point.

10. A method according to claim 9, wherein said selective heating step activates and reflows each deposition so as to form an electrically conductive adhesive joint connecting each termination with its respective mounting pad.

11. A method for reflowing solder paste on an electronic assembly, in which the assembly includes solder paste depositions atop mounting pads on a substrate and at least one electronic component having terminations arranged such that each termination rests atop a respective mounting pad, comprising the steps of:

providing said assembly;

preheating said assembly from a first predetermined temperature to a second predetermined temperature;

soaking said assembly at substantially said second predetermined temperature;

selectively heating each solder paste deposition to a third predetermined temperature above the melting point of said depositions while maintaining said substrate at substantially said second temperature; and

cooling said assembly to a fourth predetermined temperature below said second temperature.

12. A method according to claim 11, wherein said substrate is constructed of a material having a critical temperature lower than said third predetermined temperature.

13. A method according to claim 12, wherein said critical temperature is one of a melting point, a structural deformation point, and a thermal degradation point of said substrate material.

14. A method according to any one of claims 10 to 13, wherein said selective heating step melts and reflows each deposition so as to form a solder joint connecting each termination with its respective mounting pad.

15. An apparatus for reflowing bonding compound on an electronic assembly, in which the assembly includes bonding compound depositions atop mounting pads on a substrate and at least one electronic component having terminations arranged such that each termination rests atop a respective mounting pad, comprising:

means for preheating said assembly from a first predetermined temperature to a second predetermined temperature;

means for soaking said assembly at substantially said second predetermined temperature;

means for selectively heating each bonding compound deposition to a third predetermined temperature above one of a melting point and an activation point of said depositions while maintaining said substrate at substantially said second temperature; and

means for cooling said assembly to a fourth predetermined temperature below said second temperature.

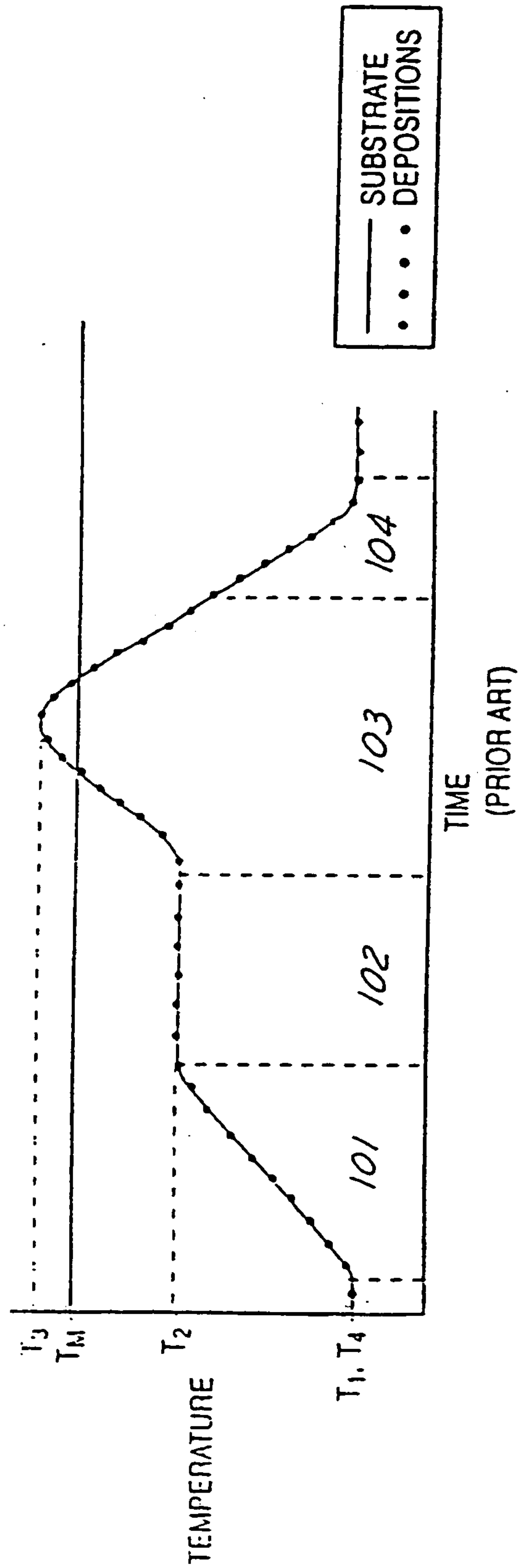
16. An apparatus according to claim 15, wherein said means for selective heating comprises a non-contact thermal energy source.

17. An apparatus according to claim 16, wherein said thermal energy source is a diode laser.

18. An apparatus according to claim 16, wherein said means for selective heating further comprises means for selectively focusing and directing heating energy from said thermal energy source onto each deposition.

19. An apparatus according to claim 16, wherein said means for selective heating further comprises means for delivering heating energy from said thermal energy source in intermittent bursts.

20. An apparatus according to claim 16, further comprising means for masking said assembly such that substantially only one or more depositions is/are exposed to heating energy when said means for selective heating is activated.



(PRIOR ART)

FIG.1

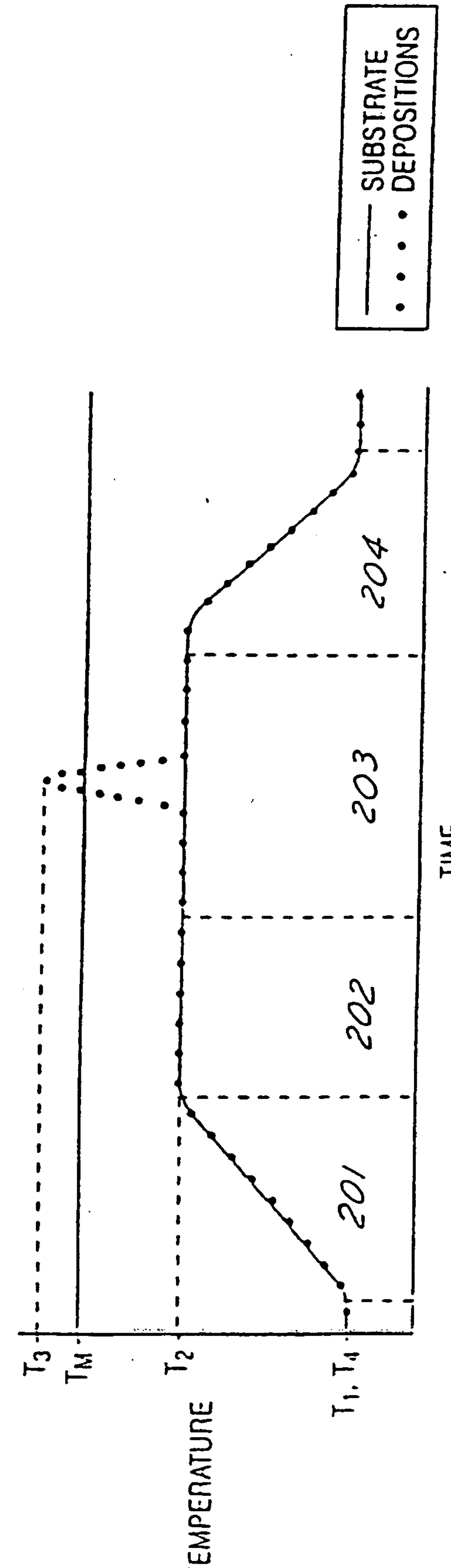


FIG.2

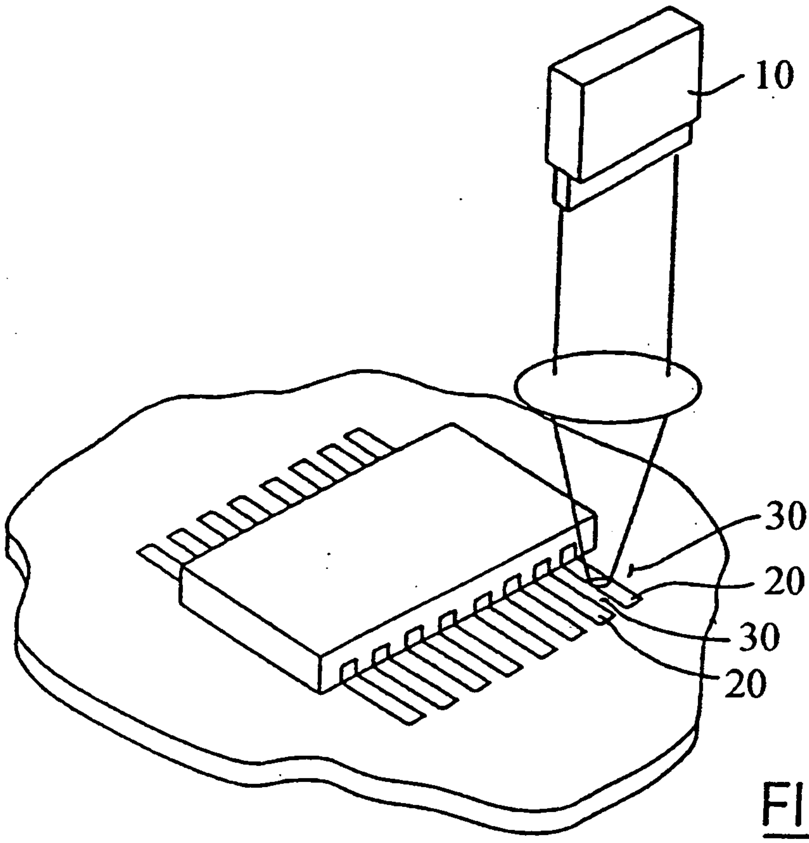


FIG. 3

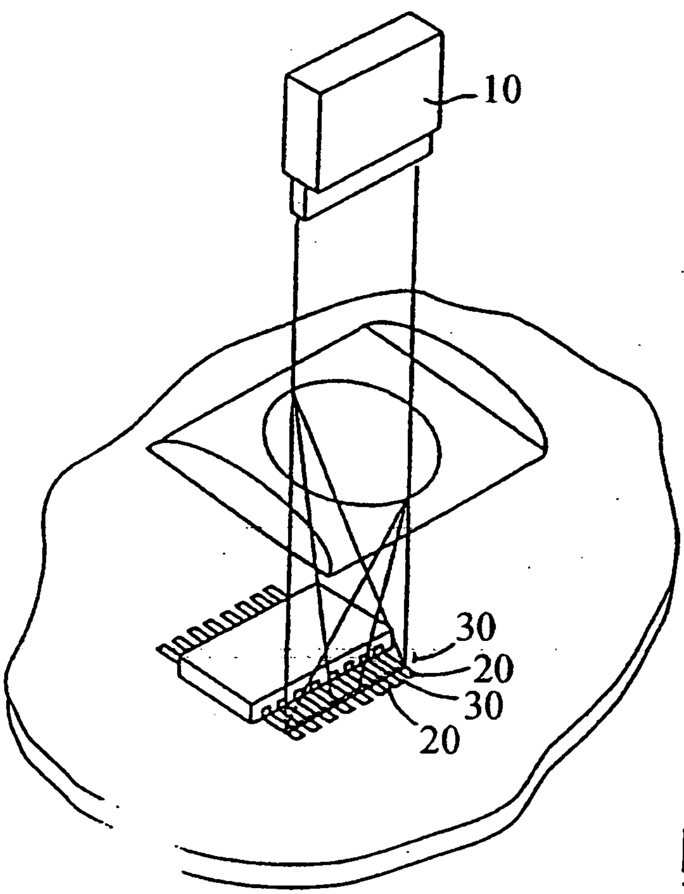
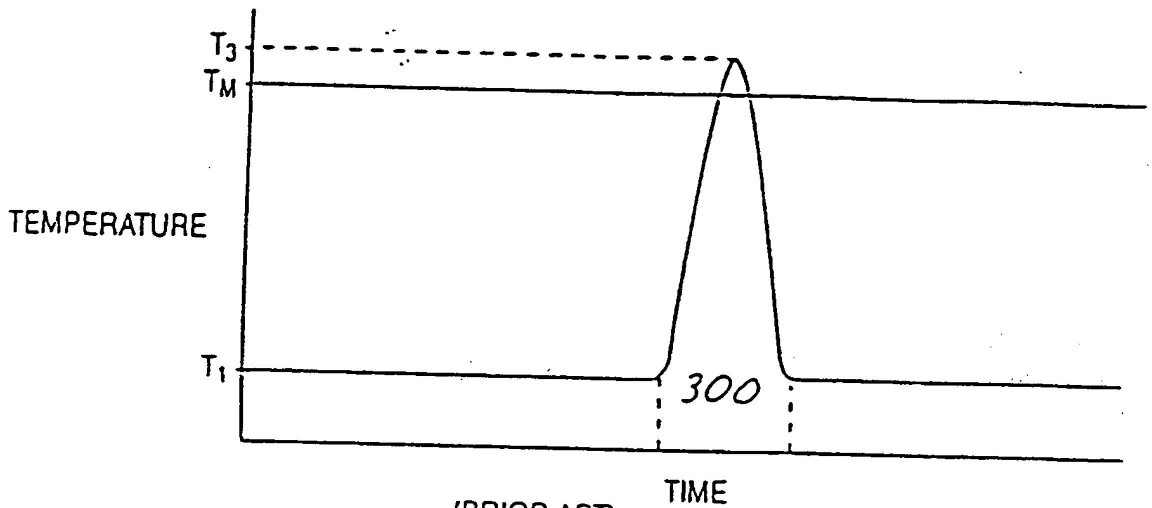


FIG. 4



(PRIOR ART)
FIG. 5

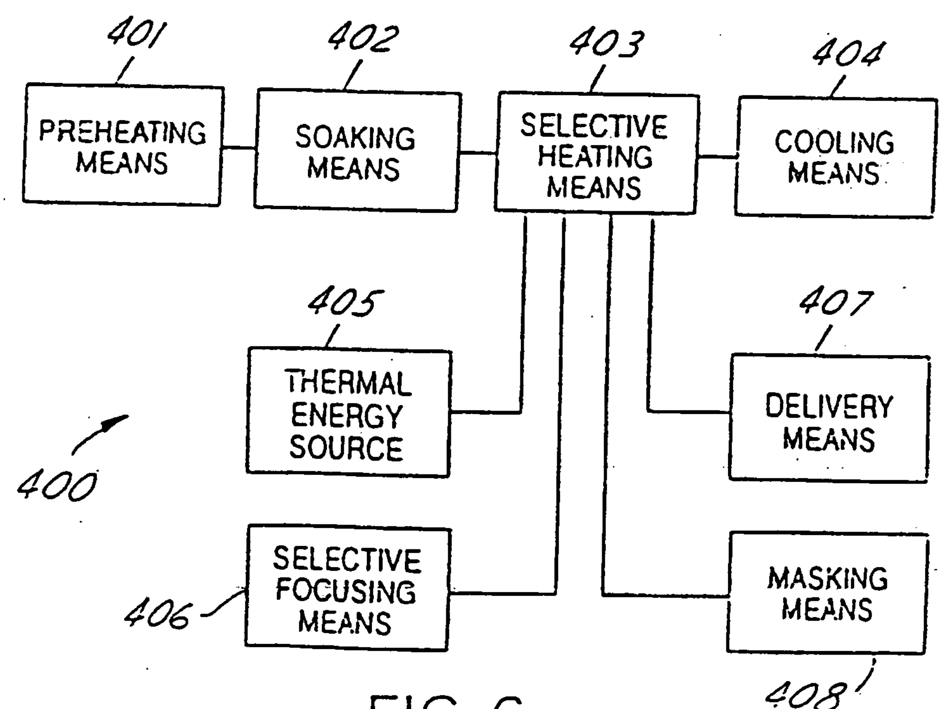


FIG. 6

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 98/02981

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H05K3/34 B23K1/005

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H05K B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 44 05 784 A (DAIMLER-BENZ AEROSPACE AG) 24 August 1995 see the whole document	1-8, 11-16
X	DE 27 35 231 A (SIEMENS AG) 15 February 1979 see the whole document	1-8, 15-19
A		11-14
X	DE 29 14 621 A (STANDARD ELEKTRIK LORENZ AG) 23 October 1980 see the whole document	1-8,15
A		11-14
X	EP 0 233 125 A (DIGITAL EQUIPMENT CORPORATION) 19 August 1987 see claims	1-8, 11-16

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 December 1998	30/12/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Mes, L

Form PCT/ISA/210 (second sheet) (July 1992)

International Application No
PCT/GB 98/02981

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
P,X	DE 196 30 676 A (FREDART SONDERMASCHINEN GMBH) 5 February 1998 see the whole document -----	1-8, 11-14

1

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
DE 4405784	A	24-08-1995	NONE			
DE 2735231	A	15-02-1979	NONE			
DE 2914621	A	23-10-1980	NONE			
EP 233125	A	19-08-1987	CA	1268022	A	24-04-1990
			DE	3787658	D	11-11-1993
			DE	3787658	T	07-04-1994
			JP	1766161	C	11-06-1993
			JP	4053118	B	25-08-1992
			JP	62271496	A	25-11-1987
			US	4817851	A	04-04-1989
DE 19630676	A	05-02-1998	NONE			